

## Article

# Does Social Network Sentiment Influence S&P 500 Environmental & Socially Responsible Index?

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**Abstract:** The influence of social network sentiment on stock market indices and companies has been proven in several studies. However, the influence of social network sentiment on sustainability indices and sustainable companies has not been analyzed so far. Therefore, this study analyzed the influence of social network sentiment on sustainability indices (S&P 500 Environmental & Socially Responsible Index) and focused on variations of this influence on sustainable and non-sustainable companies, namely, in companies included in the Information Technology sector. To this end, two methodologies were used: GARCH (1,1) models and logit-probit models. The results showed that social network sentiment influences S&P 500 Environmental & Socially Responsible Index's volatility; this influence was greater than the influence of social network sentiment when considering the S&P 500 Index. Additionally, the results showed that social network sentiment influences sustainable companies' returns but had no effect on unsustainable companies' returns. These results highlighted the importance of managing the companies' profiles in social networks and their corporate image in general, because investors will consider these aspects to design their investment strategies.

**Keywords:** sustainability indices; S&P 500 Environmental & Socially Responsible Index; social network sentiment; S&P 500 Index; Information Technology sector

## 1. Introduction

The term sustainability has been gaining relevance in recent years. There is no consensus about the meaning of sustainability; however, the definition in the Brundtland Report for the World Commission on Environment and Development [1] is considered as the original. This report defined sustainability as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (p. 5). Society increasingly demands that companies be more responsible, hence, investors choose companies that stand out for being sustainable because of the expected positive effect of that behavior on the company's long-term financial performance [2]. Therefore, companies invest in their sustainability plans and modify their policies and management strategies when necessary, because being included in a sustainability index brings them several benefits, especially intangible benefits such as access to knowledge or improved reputation [3]. Sustainable indices are stock indices composed only of companies that meet specific sustainability requirements such as being committed to the environment [3].

In recent years, there has been an increase in the number of studies analyzing the behavior of sustainable indices and their influence on the companies included [3–5]. There is no clear evidence of the benefits of being included in (or extracted from) a sustainability index, because the consequences could be even negative for the company [4]. However, the results obtained in some of these studies have suggested that sustainability indices are sensitive to market changes [5]. In this sense, research

shows that sustainability indices are influenced positively by consumer sentiment [6,7]. However, no studies have analyzed whether this influence is greater or lesser than that exerted by sentiment on other general indices. Due to the fact that these studies have only considered the sentiment of consumers, and because social network sentiment has become more important in finance research [8,9], the influence of social network sentiment on sustainable indices should be studied in depth.

Social network sentiment is the sentiment extracted from the messages posted on social networks using, in most of the cases, some language processing software [9]. Thus, this study analyzed the influence that social network sentiment has on sustainability indices, specifically its influence on S&P 500 Environmental & Socially Responsible Index's volatility, and tested whether this influence was greater or lesser than the influence of social network sentiment over the S&P 500 Index volatility. Furthermore, this research analyzed the different influence that social network sentiment had on sustainable and unsustainable companies that belong to the Information Technology (IT) sector (45 GISC) of the S&P 500 Index.

Thus, this study attempted to fill the gap in the literature on sustainable indices and their relationship with social network sentiment. The reason was that there are very few studies on the subject and most of them are focused on consumer sentiment rather than social network sentiment. In addition, most of the studies that analyzed this relationship considered the industrial sector [10], but there are none considering the IT sector. This fact, together with the idea that the IT sector has a great relationship with sustainability in many ways, since IT resources can contribute companies sustainability [11–14], and that IT is the sector with the highest weight in terms of market capitalization within the S&P 500 Index, were the reasons to justify the choice of this sector for the analysis.

To this end, two databases have been used: (i) a time series database to analyze the indices' volatility, and (ii) a panel database to analyze the influence of social network sentiment on the returns of the companies belonging to 45 GISC sector. For the first objective, GARCH (1,1) models were estimated, while logit-probit models were estimated for the second objective.

This paper is structured as follows: Section 2 provides the theoretical background, Section 3 describes the data and variables, Section 4 explains the methodology, Section 5 presents and discusses the results, and Section 6 presents the conclusions and guidelines for future research.

## 2. Literature Review

Society's demand for companies that take care of the environment and show more ethical behaviors has led companies to develop socially responsible strategies considering not only the shareholders themselves as the profit claimants, but also the rest of the stakeholders affected by their activities. These strategies, known as corporate social responsibility, are discretionary for the organization, although sometimes the society has to 'encourage' the company to adopt certain socially responsible measures [15]. Four arguments that could justify carrying out corporate social responsibility strategies are moral obligation, sustainability, a license to operate, and reputation.

For many years, the question about sustainable companies has been whether sustainability is worthwhile; that is, whether sustainable enterprises perform better. Several studies have analyzed this issue obtaining different results. For example, Horváthová [2] found that environmental performance had a negative effect on financial performance in the short term, but a positive effect in the long term. The same author in 2010 stated that in common law countries there is usually a positive link between environmental performance and financial performance [16]. By contrast, Santis, Albuquerque and Lizarelli [17] did not find differences in the financial performance between sustainable and unsustainable companies; Pintea, et al. [18] did not find a relationship between environmental performance and the companies' profitability.

Regardless of this lack of consensus, in recent years investors have preferred to invest in sustainable companies, which has led to the emergence of socially responsible investment (SRI). According to The Forum for Sustainable and Responsible Investment, the net total of SRI assets in the USA at the beginning of 2018 was \$12 trillion, which implies a 38% increase in 2016, thus indicating

a continuous growth of SRI funds. A non-expert could easily confuse SRI funds with sustainability indices. While SRIs are products offered by financial institutions that include the social and environmental criteria to select the companies, sustainability indices comprise companies committed to the environment and society and are associated with the stock exchange [3]. Therefore, companies included in a sustainable index must be socially responsible, although other factors, such as return on assets (ROA) or Tobin's Q, are also considered. Specifically, ROA and Tobin's Q have a significant positive effect on the addition to the Dow Jones sustainability index (DJSI World) and the DJSI Stoxx, respectively [19]. SRI indices can be more sensitive to market cycle changes than general indices, suggesting that market fluctuations can affect the companies included in these indices to a greater extent [5].

A company's inclusion in or exclusion from an index can lead to deterioration in returns, to an increase in trading volume and to idiosyncratic risk [4]. Despite this, the intangible value created through socially responsible activities leads companies to strive to be included in the sustainable indices [3]. Therefore, the following hypothesis was proposed:

**H1:** *S&P 500 Environmental & Socially Responsible returns are more sensitive to market volatility than S&P 500 returns.*

An indicator of these changes in the market may be investor sentiment. In fact, numerous studies have shown that this kind of sentiment is able to predict market movements. In this sense, Piñeiro-Chousa et al. [20] showed that social network sentiment can predict S&P 500 Index returns, Sabherwal, Sarkar and Zhang [21] stated that investor sentiment is a good predictor of trading activities, and Oh and Sheng [22] proved that microblog sentiment has predictive power about market returns.

Investor sentiment can be measured using consumer surveys [6,7], market variables [23,24], or sentiment from microblogs like Twitter [25], StockTwits [20], or Yahoo! Finance [26]. The sentiment can be extracted from social networks in different ways, and consequently this can report different results. Piñeiro-Chousa et al. [9,20] used the StanfordCoreNLP [27]; Zhang, Fuehres and Gloor [28] used mood words to tag Twitter messages and measure collective emotion; and Oh and Sheng [22] measured the sentiment manually, obtaining all of them positive results, i.e., that sentiment influences financial markets activity. However, Logunov and Panchenko [29], who used emoticons to measure Twitter sentiment, found that sentiment did not predict the movements of financial markets. As discussed earlier, studies analyzing the relationship between social network sentiment and sustainable indices are nonexistent. Hence, although the Environmental Quality Index (EQI) measures people's attitude and sentiment toward an area's environmental quality at a specific moment [30], to date, there is no evidence of the effect of social network sentiment on sustainability indices. Therefore, the following hypotheses were proposed:

**H2:** *Social network sentiment has an influence on S&P 500 Environmental & Socially Responsible Index's volatility.*

**H3:** *S&P 500 Environmental & Socially Responsible Index's volatility is more sensitive to social network sentiment than S&P 500 Index's volatility.*

Some studies analyzed the differences in financial performance between the companies that enter and exit the SRI indices, obtaining different results. Santis et al. [17] found no differences between the companies included in the Corporate Sustainability Index and the São Paulo Stock Exchange Index. However, Schaeffer et al. [10] found that the performance of two companies in the oil sector changed when they were included in the DJSI sustainable index.

Research shows that sectorial classification affects firms' financial performance [17]. In particular, the sector of IT has a great relationship with sustainability, which one way or another influences its financial performance. In this sense, the use of IT resources along with intellectual capital management can influence business performance in IT companies [14]. Furthermore, it has been shown that investors increasingly value the fact that a company is included over time in a sustainable index, which can

have a significant impact in terms of higher profits [31], unlike other companies not considered sustainable. This suggests that social network sentiment could influence sustainable companies' returns, whose analysis is one of the objectives of this paper. Hence the following hypotheses were proposed:

**H4:** *Social network sentiment influences the returns of the S&P 500 companies belonging to the IT sector.*

**H5:** *There are differences between the influence of investor sentiment on IT sector companies included in the S&P 500 Environmental & Socially Responsible Index and those that are not included in this index.*

### 3. Data and Variables

The databases used in this study comprise the S&P 500 Index, the S&P 500 Environmental & Socially Responsible Index, the VIX, the closing prices of the S&P 500 companies belonging to the IT sector (45 GISC), and social network sentiment. Specifically, two databases were used. The first one is a time series database composed of the daily closing prices of the S&P 500 Index, the S&P 500 Environmental & Socially Responsible Index, the VIX, and the social network sentiment. The second database is a panel defined by the S&P 500 companies ordered by date (on a daily basis). The variables included are the closing prices of the S&P 500 companies belonging to 45 GISC sector and the same variables included in the time series database. As discussed above, the IT sector was chosen because of its positive relationship with sustainability and because it is allegedly the most representative sector in the S&P 500 Index.

S&P 500 Index and S&P 500 Environmental & Socially Responsible Index data were provided by S&P Dow Jones Indices®. VIX data was downloaded from the Chicago Board Options Exchange (CBOE) website, and companies' data was downloaded from Nasdaq's website. Investor sentiment was obtained from the messages posted about S&P 500 Index in Stocktwits through the StanfordCoreNLP [27]. The database was collected from 2 January 2015 to 30 December 2016, resulting in 504 trading days.

The variables used in the analysis were the S&P 500 Index returns, the S&P 500 Environmental & Socially Responsible Index returns, the VIX returns, companies' returns, and the daily variation of sentiment. The returns were calculated as:

$$R_{it} = \ln(P_{it}) - \ln(P_{it-1}) \quad (1)$$

where  $P_{it}$  is the closing price of the S&P 500 Index, the S&P 500 Environmental & Socially Responsible Index, the VIX, or the company in moment  $t$ .

According to the StanfordCoreNLP, the sentiment obtained from each message can reach a score between  $-2$  and  $2$ , being  $-2$  the very negative sentiment,  $2$  the very positive sentiment, and  $0$  the neutral sentiment. The average of the daily sentiment was calculated as:

$$sent_t = \frac{\sum_{i=1}^m S_{it}}{M_t} \quad (2)$$

where  $S_{it}$  is the sentiment of message  $i$  posted in moment  $t$  and  $M_t$  is the number of messages posted in moment  $t$ . Then, the daily variation of sentiment was calculated as:

$$vsent_t = sent_t - sent_{t-1} \quad (3)$$

where  $sent_t$  is the daily sentiment in moment  $t$ .

The descriptive statistics for time series variables are shown in Table 1. The number of observations is 503. The calculation of the returns has led to the loss of one observation. The means of S&P 500 Index, S&P 500 Environmental & Socially Responsible Index and S&P 500 Index sentiment are positive, which suggest a bullish period. The mean of VIX returns presents a negative sign. This can suggest a decrease of the volatility during this period.

**Table 1.** Descriptive statistics for time series database.

Variable	Obs	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis
dlsp	503	0.0001672	0.0090485	−0.0402112	0.038291	−0.3144603	5.181449
dlspe	503	0.0001399	0.009043	−0.0409203	0.0381107	−0.3057461	5.280658
dlvix	503	−0.0004706	0.0818527	−0.264822	0.4010108	0.7304784	6.234881
dsent	503	0.0001332	0.0450979	−0.1512753	0.1517354	0.0210201	3.141738

dlsp: S&P 500 Index returns; dsent: variation of sentiment; dlspe: S&P 500 Environmental & Socially Responsible Index returns; dlvix: VIX returns. Period range: 2 January 2015–30 December 2016.

Table 2 presents the summary statistics for panel data variables with 33,950 observations. The statistics of S&P 500 Index, S&P 500 Environmental & Socially Responsible Index, VIX, and sentiment are the same as in Table 1. Companies' returns are represented by a dichotomous variable (1, 0). The panel data was divided into two subsamples, one subsample includes the returns of the companies of the 45 GISC sector that are included in the S&P 500 Environmental & Socially Responsible Index; the other includes the returns of the companies that are included only in the S&P 500 Index. '1' is for positive or zero returns, and '0' indicates negative returns. The average of the three variables is slightly above 0.5, which means that yields are slightly positive.

**Table 2.** Descriptive statistics for panel data.

Variable	Obs	Mean	Standard Deviation	Min	Max	Skewness	Kurtosis
dlsp	33,950	0.0001667	0.0090448	−0.0402112	0.038291	−0.3137936	5.180599
dlspe	33,950	0.0001393	0.0090393	−0.0409203	0.0381107	−0.305298	5.279491
dlvix	33,950	−0.000474	0.0818038	−0.264822	0.4010108	0.7312325	6.229161
dsent	33,950	0.0001366	0.0450668	−0.1512753	0.1517354	0.0208434	3.140535
dlcd	33,403	0.524414	0.4994111	0	1	−0.0977725	1.009559
dlcd1	20,044	0.5247955	0.4993973	0	1	−0.099304	1.009861
dlcd0	13,359	0.5238416	0.4994499	0	1	−0.095475	1.009115

dlsp: S&P 500 Index returns; dsent: variation of sentiment; dlspe: S&P 500 Environmental & Socially Responsible Index returns; dlvix: VIX returns; dlcd: 45 GISC companies returns (dichotomic); dlcd1: returns of the 45 GISC companies included in the S&P 500 Environmental & Socially Responsible Index (dichotomic); dlcd0: returns of the 45 GISC companies included in the S&P 500 Index, but not in the S&P 500 Environmental & Socially Responsible Index (dichotomic). Period range: 2 January 2015–30 December 2016.

## 4. Method

### 4.1. GARCH Model

A GARCH (1,1) model was proposed to analyze S&P 500 and S&P 500 Environmental & Socially Responsible Index's volatility. This method has been previously used to analyze the indices' volatility [10]. The mean model was defined as:

$$Rs_t = \beta_0 + \beta_1 Rv_t + \epsilon_t \quad (4)$$

where  $Rs_t$  represents the daily S&P 500 or S&P 500 Environmental & Socially Responsible Index returns, and  $Rv_t$  represents the daily VIX returns.

The variance model was defined as:

$$\sigma_t^{spi} = C_{spi} + \gamma_{spi} \epsilon_{t-1}^2 + \delta_{spi} \sigma_{t-1}^2 + \beta_1 v_{sent_t} \quad (5)$$

where  $\sigma_t^{spi}$  is the variance of the residuals derived from the mean model equation,  $C_{spi}$  is the constant,  $\gamma_{spi} \epsilon_{t-1}^2$  is the ARCH parameter,  $\delta_{spi} \sigma_{t-1}^2$  is the GARCH parameter,  $\beta_1$  is the coefficient of the exogenous variable (variation of sentiment), and  $v_{sent_t}$  is the daily variation of sentiment.



## 4.2. Logit and Probit

To test the influence of social network sentiment on the companies included in 45 GISC sector of the S&P 500 and the S&P 500 Environmental & Socially Responsible Index a logit-probit model was proposed. This method was appropriate to analyze the effect of the increase or decrease of social network sentiment and market volatility on companies' returns. The equal-correlation logit-probit model was proposed as:

$$dlcd_{ti} = \beta_0 + \beta_1 dsent_t + \beta_2 dlvi x_t + \varepsilon_t \quad (6)$$

where  $dlcd_{ti}$  represents the daily returns of the companies (dichotomic variable),  $dsent_t$  is the daily variation of sentiment, and  $dlvi x_t$  represents the daily returns of VIX. These models were estimated using population-averaged estimator, thus, the  $\beta$  in these models measures the change of proportion with  $y = 1$  for a unit increase in  $x$  [32].

## 5. Results

### 5.1. GARCH Results

Two GARCH (1,1) models were estimated to test the volatility of S&P 500 Index and S&P 500 Environmental & Socially Responsible Index and the influence that social media sentiment has over them. The results of the estimation are shown in Table 3. The models support the GARCH (1,1) because the  $p$  value was significant in both cases. The results of the mean equation showed that both the S&P 500 returns and the S&P 500 Environmental & Socially Responsible Index returns were influenced by VIX returns in a negative way. This result means that both indices reacted to market volatility; therefore, if volatility increased, both indices decreased, and vice versa. Moreover, the coefficient of VIX returns was higher in the model of S&P 500 Environmental & Socially Responsible returns, which means that this index is more sensitive to changes in market volatility than the S&P 500 Index. These results are in line with previous studies [5] and confirm H1.

Table 3. GARCH estimation results.

Variables	S&P 500 Returns		S&P 500 Environmental & Socially Responsible Returns	
Mean equation				
dlvix	−0.0790945	(0.000)	−0.0774492	(0.000)
Cons	0.0001988	(0.266)	0.0001979	(0.259)
Variance equation				
dsent	19.53896	(0.000)	22.14252	(0.000)
ARCH	0.1940632	(0.000)	0.1918049	(0.000)
GARCH	0.7480837	(0.000)	0.7628726	(0.000)
Cons	−13.81924	(0.000)	−14.07576	(0.000)

dsent: variation of sentiment; dlvix: VIX returns; cons: constant; ARCH: ARCH parameter; GARCH: GARCH parameter. Coefficients that were significant at the 5% confidence level are reported in bold. Coefficients that were significant at the 10% confidence level are reported in bold and italics. Period range: 2 January 2015–30 December 2016.

Regarding the variance equation, the significant ARCH coefficient shows that S&P 500 returns' volatility in the previous days influences S&P 500's volatility. S&P 500 Environmental & Socially Responsible returns' volatility is influenced by the previous days' S&P 500 Environmental & Socially Responsible returns' volatility. The significant GARCH coefficient implies that the previous days' volatility influences S&P 500's or S&P 500 Environmental & Socially Responsible's volatility, respectively. Therefore, these results imply that S&P 500's volatility and S&P 500 Environmental & Socially Responsible's volatility are adequately modeled through the GARCH (1,1) model. The variation of sentiment is significant in both models, which means that the variation of sentiment influences the volatility of both indices. These results are in line with previous studies [6,7] and confirm H2. Furthermore, the coefficient is higher in the S&P 500 Environmental & Socially Responsible

estimation, confirming H3. These results imply that this index is more sensitive to sentiment variation than the other and could mean that the companies included in this index pay more attention to what is being said in social networks than unsustainable companies.

## 5.2. Logit-Probit Results

Table 4 shows the logit-probit results for the whole sample. The results of both regressions were similar, and all variables were significant. The influence of the variation of social network sentiment was positive, which implies that an increase of social network sentiment led to an increase of the companies' returns. However, VIX returns show a negative coefficient, which means that companies' returns reacted inversely to an increase in VIX returns. These results confirm H4. Hausman's test was performed to identify the best model. The results indicate that the probit model was the best.

**Table 4.** Logit and probit estimation results for the full database.

	Logit		Probit	
dsent	1.045132	(0.000)	0.7204698	(0.000)
dlvix	−16.12687	(0.000)	−9.448296	(0.000)
Cons	0.0853293	(0.000)	0.0514306	(0.000)
Hausman	chi2(2)=	1354.41	(0.000)	

dsent: variation of sentiment; dlvix: VIX returns; cons: constant. Coefficients that were significant at the 5% confidence level are reported in bold. Coefficients that were significant at the 10% confidence level are reported in bold and italics. Period range: 2 January 2015–30 December 2016.

To test whether the influence of social network sentiment is different for companies belonging to the S&P 500 Environmental & Socially Responsible Index than for companies belonging only to the S&P 500 Index, two logit-probit models were estimated for both subsamples. Tables 5 and 6 show the results. Regarding the results for the first subsample, the results are similar to those obtained for the whole sample. Therefore, the variation of social network sentiment and VIX returns is significant in a positive and negative way, respectively. These results suggest that sustainable companies of the 45 GISC sector are sensitive to social network sentiment. Thus, investors that participate in these companies pay attention to what is said in social networks. However, the returns of companies that are included only in the S&P 500 Index, that is, unsustainable companies are not sensitive to social network sentiment. These results confirm H5 and are in line with [31]. Again, the results of Hausman's test identify the probit as the best model in both cases.

**Table 5.** Logit and probit estimation results for companies belonging to S&P 500 Index and S&P 500 Environmental & Socially Responsible Index.

	Logit		Probit	
dsent	<b>1.516881</b>	<b>(0.000)</b>	<b>1.035143</b>	<b>(0.000)</b>
dlvix	<b>−16.19453</b>	<b>(0.000)</b>	<b>−9.44234</b>	<b>(0.000)</b>
Cons	<b>0.0862469</b>	<b>(0.000)</b>	<b>0.0554444</b>	<b>(0.000)</b>
Hausman	chi2(2)=	826.66	(0.000)	

dsent: variation of sentiment; dlvix: VIX returns; cons: constant. Coefficients that were significant at the 5% confidence level are reported in bold. Coefficients that were significant at the 10% confidence level are reported in bold and italics. Period range: 2 January 2015–30 December 2016.

**Table 6.** Logit and probit estimation results for companies belonging to S&P 500 Index.

	Logit		Probit	
dsent	0.3419227	(0.434)	0.2525984	(0.337)
dlvix	<b>−16.03043</b>	<b>(0.000)</b>	<b>−9.463092</b>	<b>(0.000)</b>
Cons	<b>0.0828646</b>	<b>(0.000)</b>	<b>0.048132</b>	<b>(0.000)</b>
Haussman	chi2(2)=	527.64	(0.000)	

dsent: variation of sentiment; dlvix: VIX returns; cons: constant. Coefficients that were significant at the 5% confidence level are reported in bold. Coefficients that were significant at the 10% confidence level are reported in bold and italics. Period range: 2 January 2015–30 December 2016.

## 6. Discussion and Implications

This study analyzed the influence of social network sentiment on the S&P 500 Environmental & Socially Responsible Index and the difference between social network sentiment's influence on this index and on the S&P 500 Index. Moreover, the influence of social network sentiment over the most representative companies of the IT sector in the S&P 500 Index was tested. The results showed that there were differences between sustainable and unsustainable companies. Namely, social network sentiment about the S&P 500 Index influences S&P 500's volatility and S&P 500 Environmental & Socially Responsible's volatility, the latter being the largest influence. This suggests that the S&P 500 Environmental & Socially Responsible Index is more sensitive to what is happening in the stock market, which means that sustainable companies are also more sensitive to market activity.

Moreover, the results indicated that social network sentiment influenced companies' returns, specifically those belonging to the 45 GISC sector. In particular, returns of sustainable companies of this sector were influenced by social network sentiment, but returns of unsustainable companies were not. This could mean that investors on sustainable companies consider social network information to decide their investment strategies, and unsustainable investors considered other sources of information.

The results obtained have many implications for investors and companies. Sustainable investors seem to be influenced by what is said on social networks, and this influence affects both sustainable and unsustainable companies. Therefore, sustainable and unsustainable companies should have a good management of their profiles in social networks and a good management of their corporate image overall. Implementing an adequate corporate social responsibility strategy will positively influence investors, who will take these companies into account as a possibility of investment. Sustainable companies should want to continue in (and unsustainable companies should want to enter) the sustainable indices because their image and reputation will be improved. Summarizing, social networks are growing in number and users, which leads to a faster spread of information. Issues like fake news must be analyzed in depth, because it is a growing phenomenon whose main propagation is through social networks and that can cause irreparable damage to the company. All of this forces companies to have a better knowledge of what is said about them in social networks, and at the same time to have a good management of their social networks' profiles. The reason is that not acting correctly and quickly to cushion bad or fake comments from a stakeholder can mean a significant decline in companies' market value.

## 7. Conclusions

This study shows that social network sentiment influences S&P 500 Environmental & Socially Responsible Index volatility and IT sustainable companies' returns, which means that investors also consider sustainable and socially responsible companies when they design their investment strategies.

As any empirical study, this study had some limitations. Only the S&P 500 Index and the S&P 500 Environmental & Socially Responsible Index were considered. Although there are more sustainable indices that could be considered for the analysis, such as the DSJI or the FTSE4Good, the S&P 500 Environmental & Socially Responsible Index was chosen because it comprises a great number of companies from different economic sectors and there is little literature about this index. The sector



chosen for the analysis can be another limitation; however, this choice is due, among other reasons, to the fact that the IT sector is related to sustainability and it is the most representative sector in the S&P 500 Index in terms of market capitalization.

Future research should analyze the influence of social network sentiment on sustainable indices from different perspectives, considering different companies, different industrial sectors, and different sustainable indices. Furthermore, it would provide valuable findings to analyze the relationship between social network sentiment and sustainable companies' performance at an international level, considering different sustainable indices from different countries or geographical areas and different ways of measuring sentiment with the aim of corroborating the results obtained in this study.

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